AVERAGE ANNUAL PRECIPITATION FROM DAILY AMOUNTS OF 0.50 INCH OR GREATER*

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ABSTRACT

Three charts of the contiguous United States show (1) the percentage of mean annual total precipitation contributed by daily amounts of 0.50 in. or greater, (2) the average annual accumulation of these daily amounts, and (3) the average annual number of days having precipitation of 0.50 in. or greater.

1. INTRODUCTION

An expression for estimating gully erosion [1] has a climatic factor consisting of the average annual precipitation from daily amounts of 0.50 in. or greater. Lesser amounts, in general, apparently contribute very little to this type of erosion. In order to permit the estimation of gully erosion over the 48 contiguous States, a map showing the required climatic factor was developed. Another map shows percentage of mean annual total precipitation contributed by days with 0.50 in. or more of precipitation, and a third map shows the average annual number of such days.

2. DATA AND PROCEDURE

Time and economic considerations precluded an extensive study and determined the approach, number of stations, and period of record used. The three maps were based on daily precipitation amounts for the 20-yr. period, 1942–61, for 315 stations.

The 20-yr. period was selected on the basis of comparisons of the results of analyses of 10-, 20-, and 50-yr. records for 77 stations. These comparisons showed relatively small differences between the results obtained from the 20- and 50-yr. records, but the results based on the 10-yr. records showed considerable variation from those based on the longer periods. It appeared therefore that the 20-yr. period was about the shortest period that could be used to provide results that could be accepted as reasonably representative of the regime of daily precipitation amounts of 0.50 in. or greater.

The number of stations used was about the minimum required for the degree of detail specified for the maps. About one-third of the 315 stations were selected because their daily precipitation amounts were already on punched cards, and the data could be summarized easily by electronic computer. The remainder were selected to balance the geographic distribution as much as possible in level regions and to provide greater concentrations in mountainous regions, where the greatest variations in precipitation are to be found.

Daily amounts of 0.50 in. and greater at each station were accumulated for the 20-yr. period, 1942–61, and the totals were divided by 20 to get the average annual accumulation. This average for each station was then expressed as percentage of the station's mean annual total precipitation. Both the average annual accumulations and the percentages were plotted against mean annual total precipitation to obtain the relations of figures 1 and 2. While these relations are not independent of one another, i.e., one can be obtained directly from the other, they were derived separately. Comparison shows they yield equivalent values. Another relation (fig. 3) was developed between the average annual accumulation and the average annual number of days with precipitation amounts of 0.50 in. or more.

The percentage values for the 315 stations were plotted on a map, and isopercental lines were drawn. In the drawing of these lines, the isohyetal map of mean annual total precipitation in the National Atlas [2] and the relation of figure 2 were used to estimate percentage values between stations. The resulting isopercental map is shown in figure 4. A ½° grid was constructed on this map, and percentages were read for each ½° interval, except over flat terrain where percentages were read for 1° intervals only.

Next, values of mean annual total precipitation for the same grid points were read from the National Atlas map and multiplied by the corresponding percentage values to obtain estimates of the average annual precipitation from days having 0.50 in. or more of precipitation. These estimates were plotted at their respective grid points, and isohyets were drawn (fig. 5).

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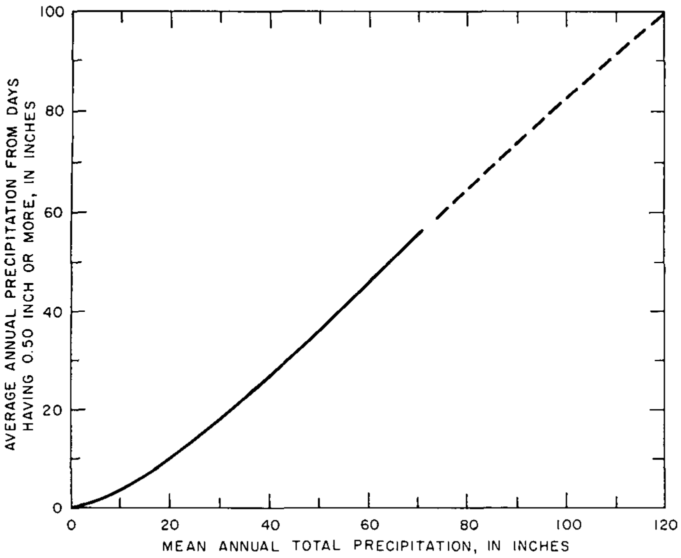

FIGURE 1.—Average annual precipitation from daily amounts of 0.50 in. or more vs. mean annual total precipitation.

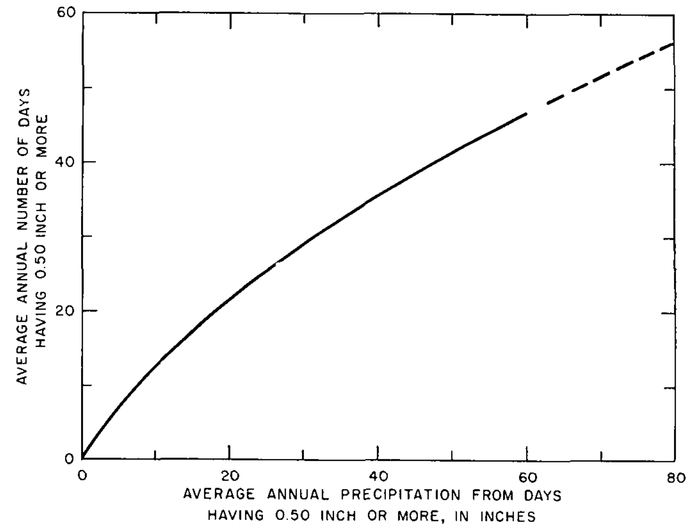

FIGURE 3.—Average annual number of days with precipitation of 0.50 in. or more vs. average annual precipitation from daily amounts of 0.50 in. or more.

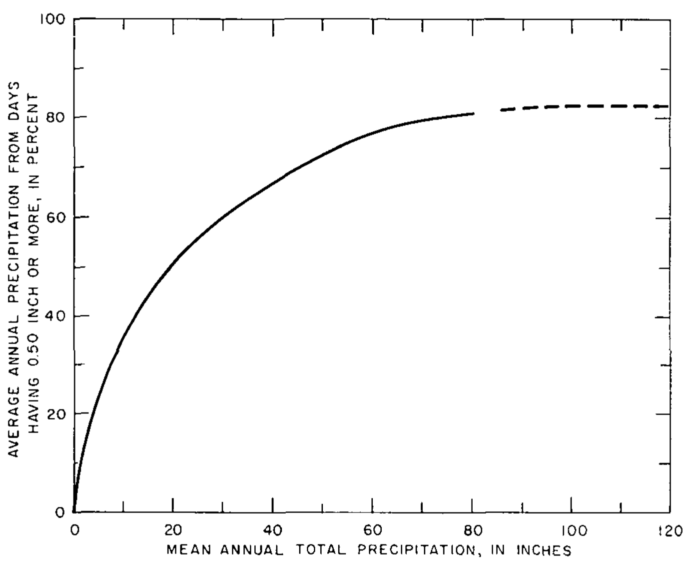

FIGURE 2.—Average annual precipitation from daily amounts of 0.50 in. or more in percent of mean annual total precipitation.

The average annual number of days of precipitation of 0.50 in. or greater was obtained for each of the 315 stations and plotted on a map. The map was then superimposed on that of figure 5, and isolines were drawn on the basis of the plotted data, the isohyets of figure 5 and relation of figure 3 serving as guides for interpolation between stations. The resulting map is presented in figure 6.

3. DISCUSSION

The relation of figure 1 was found to have an index of correlation of 0.98, and a standard error of estimate of 3.1 in. The mean of the 315 observed values of annual precipitation from days with 0.50 in. or more was 17.2 in. The index of correlation of the relation of figure 2 was 0.81, and the standard error 11.9 percent, the mean of the observed percentage values being 51.4 percent. Both relations indicated a tendency for a geographic bias. The estimates tended to be too low in California, the Southern and Central Plains Regions, and the Southeastern States. They tended to be too high in the Northwest, the northern and central Rocky Mountain States, and the Great Lakes Region.

The relation of figure 3 had an index of correlation of 0.98, a standard error of 2.5 days, the mean of the observed annual number of days with 0.50 in. or more being 16.2 days. This relation also showed indications of geographic bias, the estimates tending to be too low east of the Mississippi River and too high to the west.

Refinement of the relations of figures 1, 2, and 3 to adjust for geographic biases was considered but not attempted. The magnitude of the bias was, in general, relatively small, and the standard error of estimate of each relation was within acceptable limits. Moreover, the amount of processed data available was judged to be inadequate for delineating different relations for correcting for bias and degrees of bias. The relations were used only for interpolating between plotted points in the construction of the maps of figures 4, 5, and 6. With greatest weight given to the observed data, the effects of geographic bias were thus reduced.

The map of figure 4 shows that the proportion of mean annual total precipitation contributed by daily amounts of 0.50 in. or greater ranges from slightly less than 20 percent in the Great Basin to over 90 percent

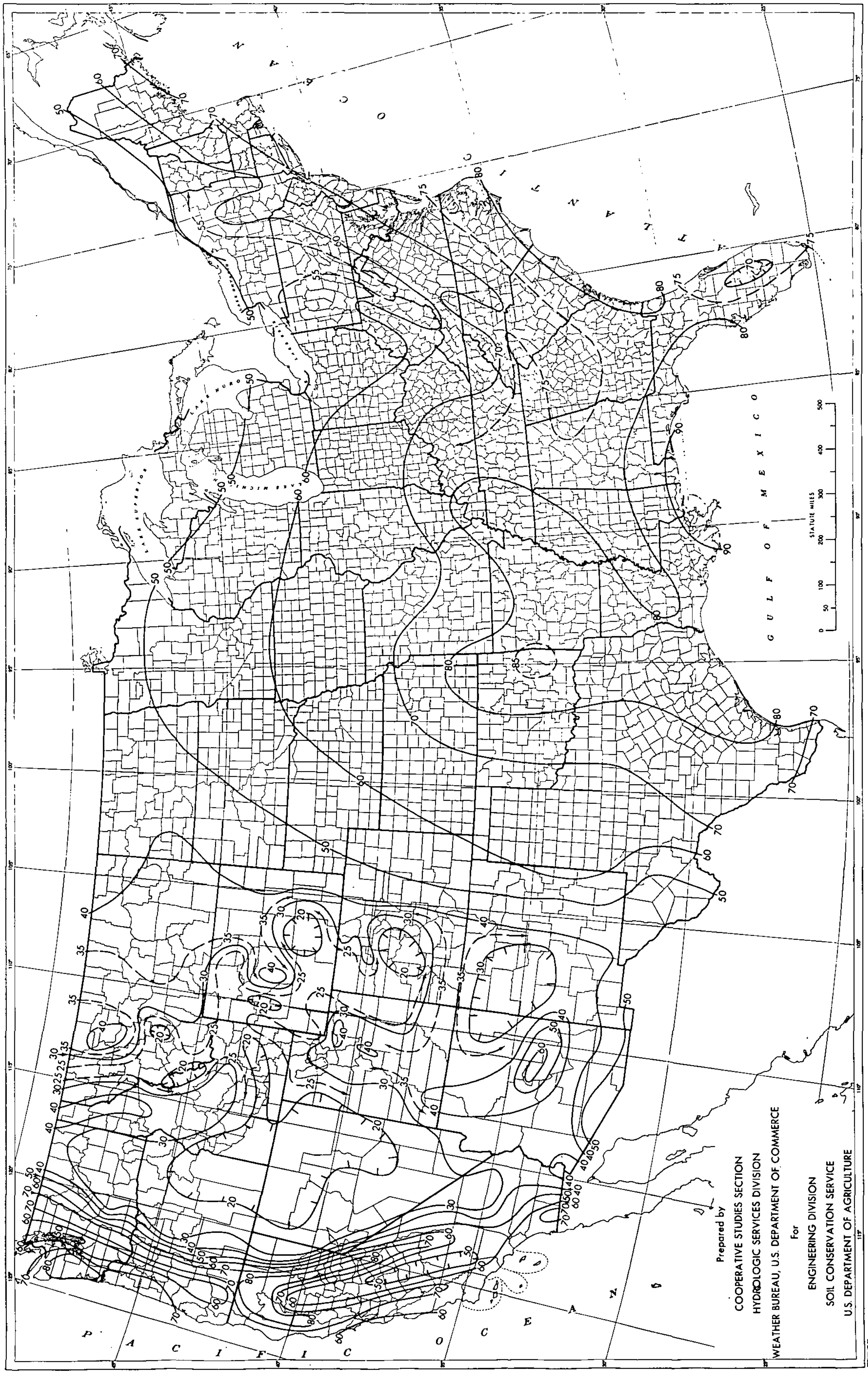

FIGURE 4.—Percentage of mean annual total precipitation from daily amounts of 0.50 in. or more. (Based on 315 stations for the 20-yr. period 1942–61.)

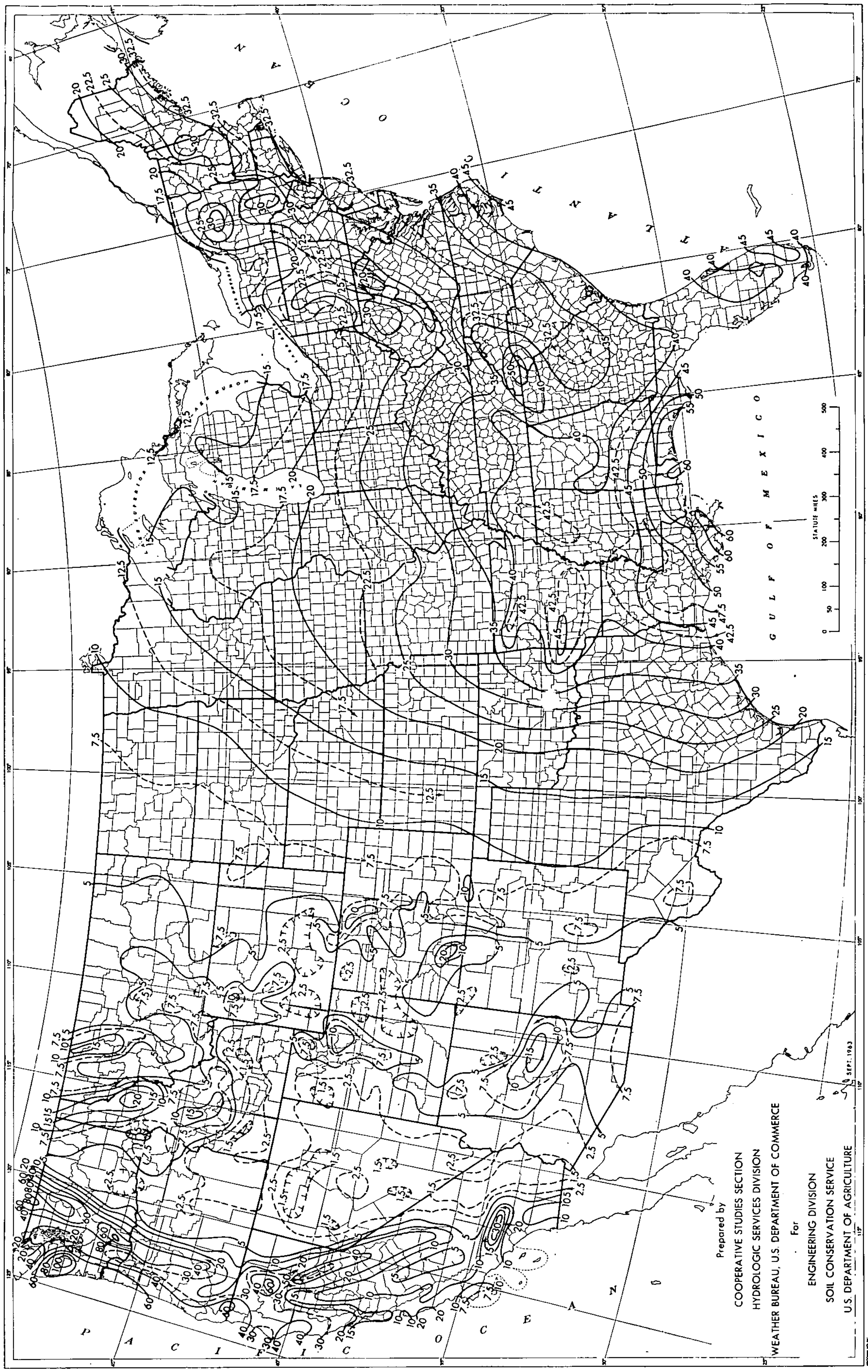

FIGURE 5.—Average annual precipitation from daily amounts of 0.50 in. or more. (Derived from fig. 4 and National Atlas mean annual total precipitation chart, which is based on 3515 stations for the 25-yr. period 1931–55.)

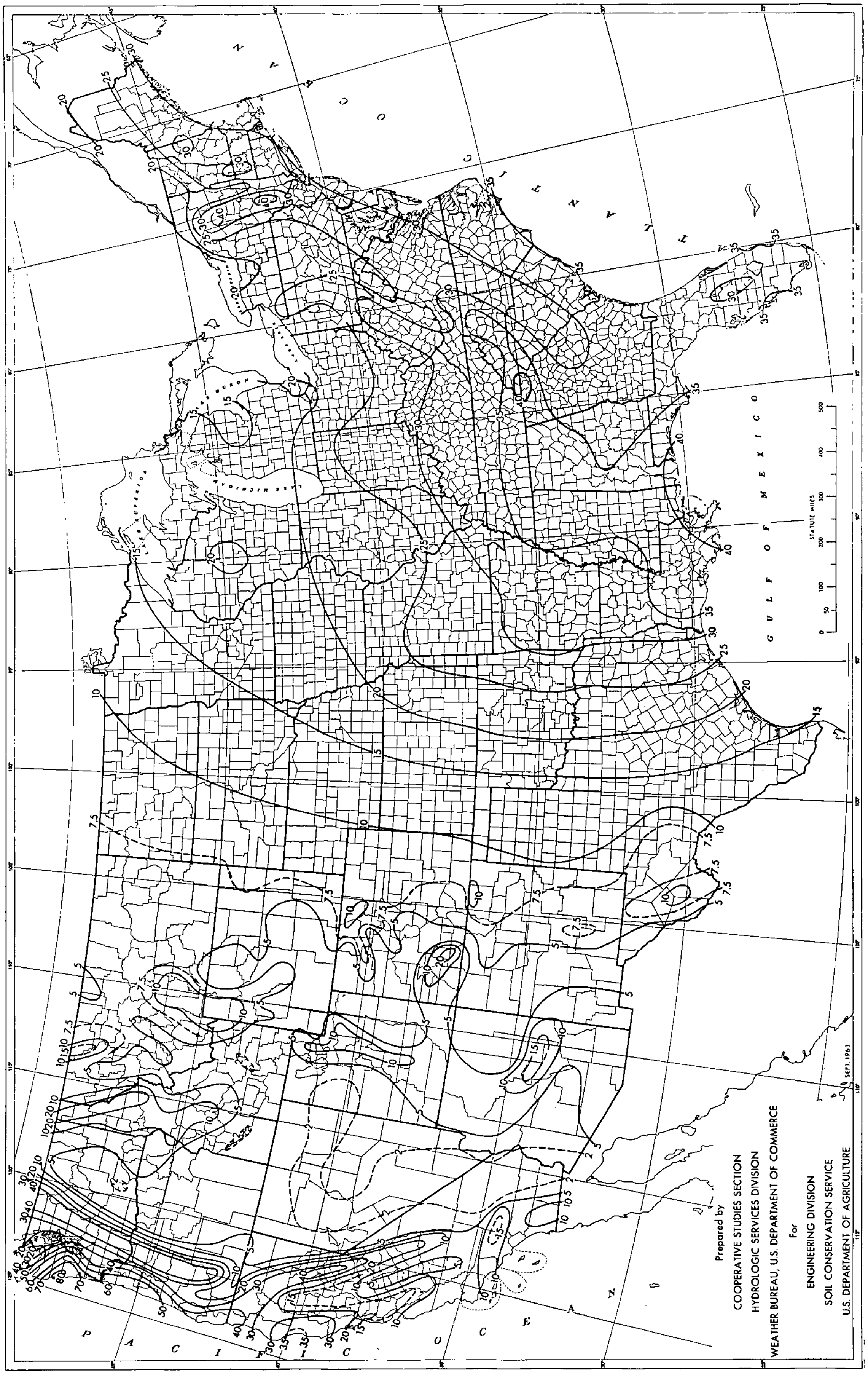

FIGURE 6.—Average annual number of days with precipitation amounts of 0.50 in. or more. (Based on 315 stations for the 20-yr. period 1942–61.)

on the north coast of the Gulf of Mexico. There is a gradient from 90 to 50 percent between the Gulf of Mexico and the upper Great Lakes Region. Other centers of maximum percentage values are those over the Sierra Nevada and the Cascade and Coast Ranges (70 to over 80 percent). In general, percentages are higher on windward slopes and ridges of the main orographic barriers and lower on lee slopes and other areas generally sheltered from moisture-bearing winds in storm situations.

As stated above, the map of average annual precipitation from daily amounts of 0.50 in. or more (fig. 5) was based on the percentage map and the relatively highly detailed map (3515 stations) of mean annual total precipitation in the National Atlas. This was done in order to provide as much detail as possible from the relatively small amount of data analyzed. More detail could have been obtained through the use of a ¼° grid, but such a degree of detail was unwarranted because the specifications called for the final map to be small enough for insertion in a standard-size manual with no more than one fold. It should be noted that the map of figure 5 could also be obtained by applying the relation of figure 1 to the National Atlas isohyetal map of mean annual total precipitation, with elimination of some of the details of the latter to provide the degree of smoothness depicted.

The values shown on the map of figure 5 range from less than 1.5 in. in the Great Basin to over 80 in. in the Cascades. In the eastern half of the country, the values decrease from a high of 60 in. on the northern Gulf Coast to about 12.5 in. in the northern Great Lakes Region. As is to be expected, the amounts tend to be high along windward slopes and ridges and low in sheltered areas.

The average annual number of days with 0.50 in. or more of precipitation (fig. 6) ranges from less than 2 in the Great Basin to about 80 of the coast of Washington. Maxima of over 40 days are shown along the Cascades and Sierra Nevada, the northern coast of the Gulf of Mexico, and at several places along the Appalachians. It is of interest to note that the relation of figure 3 indicates that the average daily amounts for days having 0.50 in. or more increases with the average annual number of such days. Two days, for example, would have an average amount of about 0.6 in. per day; 40 days would have about 1.2 in. These are average values, of course, and values computed by dividing the annual precipitation amounts of figure 5 for specific points by the corresponding average number of days of figure 6, do not necessarily agree with those indicated by figure 3.

The isolines of figures 4 to 6 are the result of a regional generalization of station data. Values for a particular point or station may differ appreciably from those indicated by the maps. These differences may arise from smoothing to compensate for sampling variations or from difficulty in delineating sufficient detail on a map, especially one of small scale. Differences are largest and most prevalent over mountainous regions. There are several places on the maps, for example, in the Sierra Nevada, Cascades, Coast Ranges, and Appalachians, where centers of higher values than maxima shown had to be omitted because of overcrowding of isolines or because the centers would have reduced almost to a point on the final maps.

In collecting the data for the maps no distinction was made between rain and snow. Consequently, for some of the warmer regions the information presented on the maps is based entirely or almost entirely on rainfall data, whereas for the colder regions or higher elevations an appreciable proportion of precipitation in the form of snow may be involved. The study assignment did not specify separation of snow and rain as a requirement.

The three maps were based on observational-day data, i.e., for the 24-hr. period between observations regardless of whether the observations were taken at 8 a.m., 5 p.m., or some other time. If the maps had been based on 24-hr. precipitation amounts of 0.50 in. or more instead of on observational-day amounts, they would show somewhat higher values, because the occurrence at a station of amounts of less than 0.50 in. on two successive days yet totaling 0.50 in. or more in a 24-hr. period is not infrequent. The differences that might exist between the results based on the two types of data are not known, but it is not likely that they would be appreciable. However, since the expression for estimating gully erosion utilizes average annual precipitation based on observational-day amounts of 0.50 in. and greater, the map of figure 5 is the proper one to use.

ACKNOWLEDGMENTS

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